# Study on HBD based Lvl1 trigger in p-p collision

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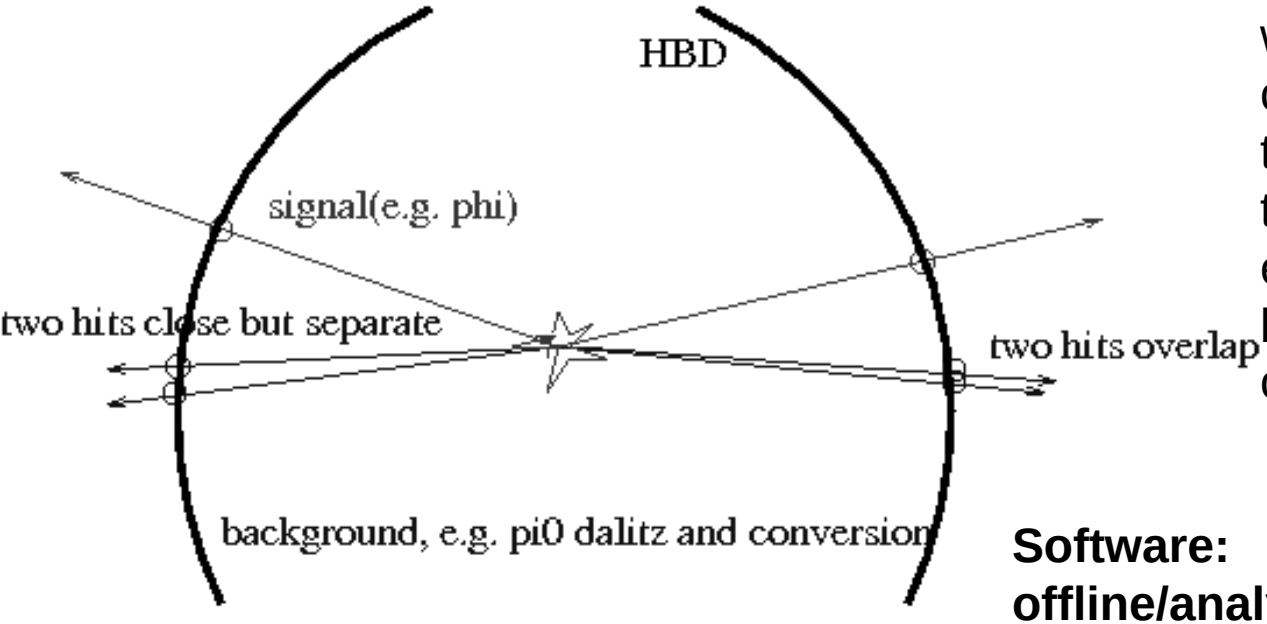
# Trigger algorithm

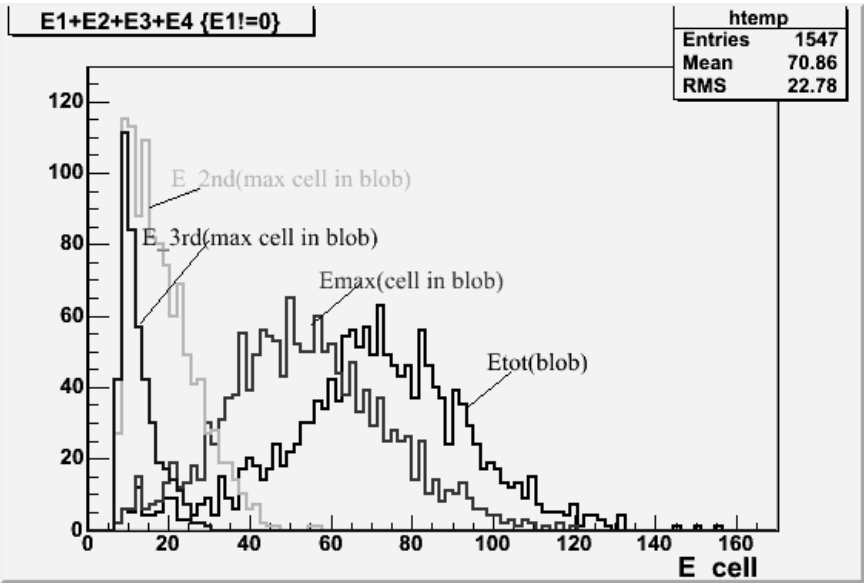
- Electron pairs from low mass vector meson have large opening angle (note: at low pT).
- Most of the background are from dalitz and conversions and the opening angle is very small and some even overlap in the same HBD blob.
- The algorithm for this study is:

1. distance cut: accept a event if it contains two trigger tile with distance larger than the cut, otherwise reject the events. This is to remove the events that contains only the background and has two close hits.
2. Charge cut: reject a event if it contains one trigger tiles with charge larger than the cut and distance with other trigger tile is smaller than the cut. This is to remove event containing only background whose electron overlap.



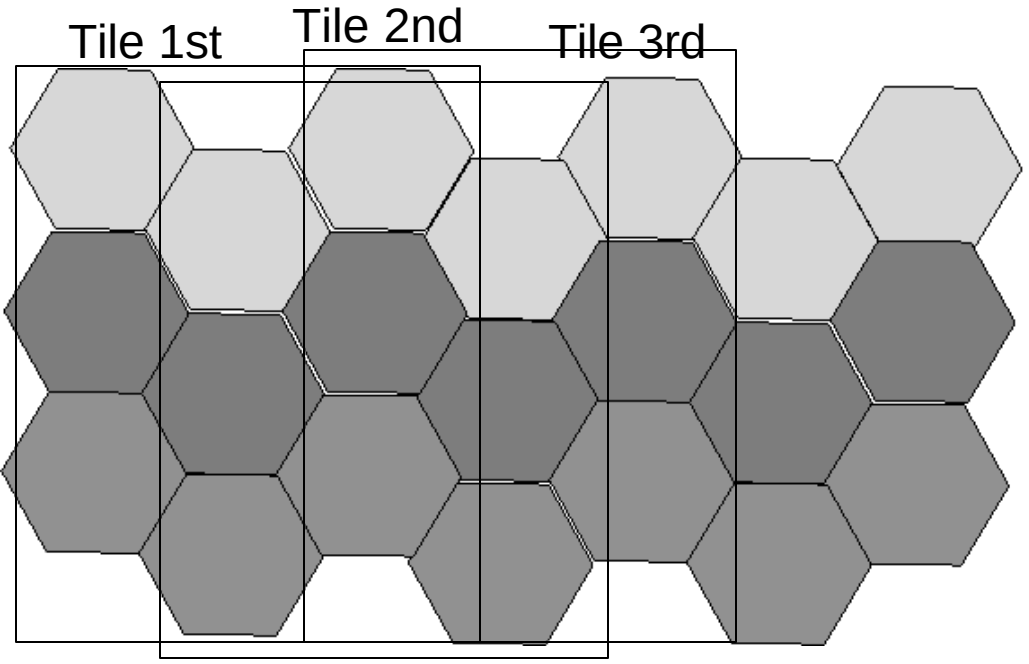

**Software: offline/analysis/HBD_trigger**

# Trigger Tile Selection




The cell with maximum charge in a blob contains 2/3 of the total charge of a blob and is clearly distinguished from the other cells.

One option is to treat each cell as a trigger tile: this is called single cell methods

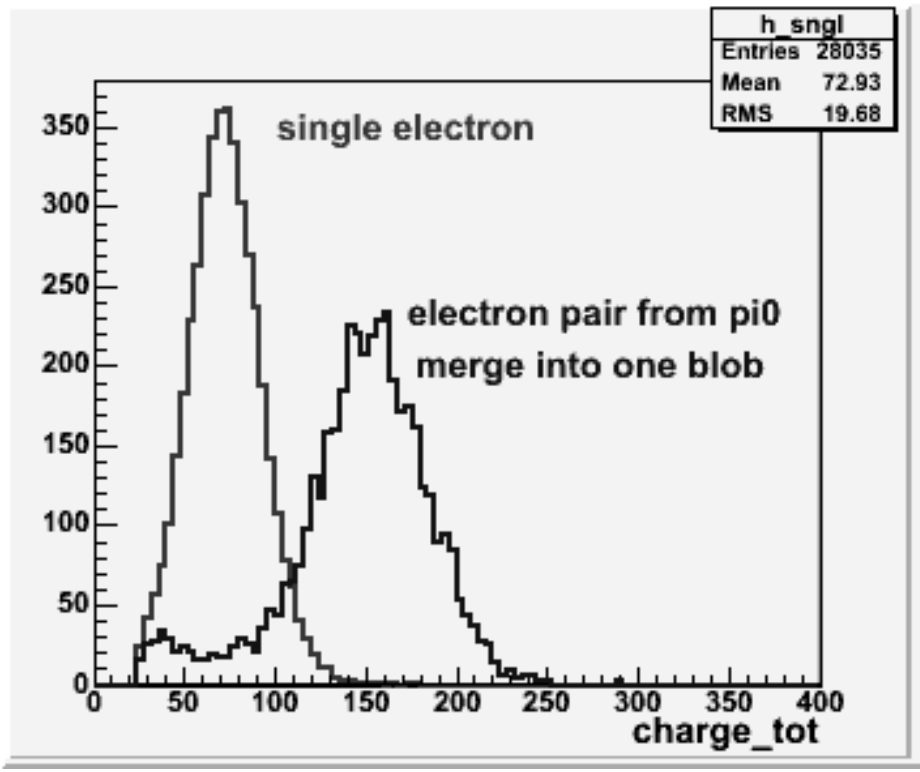


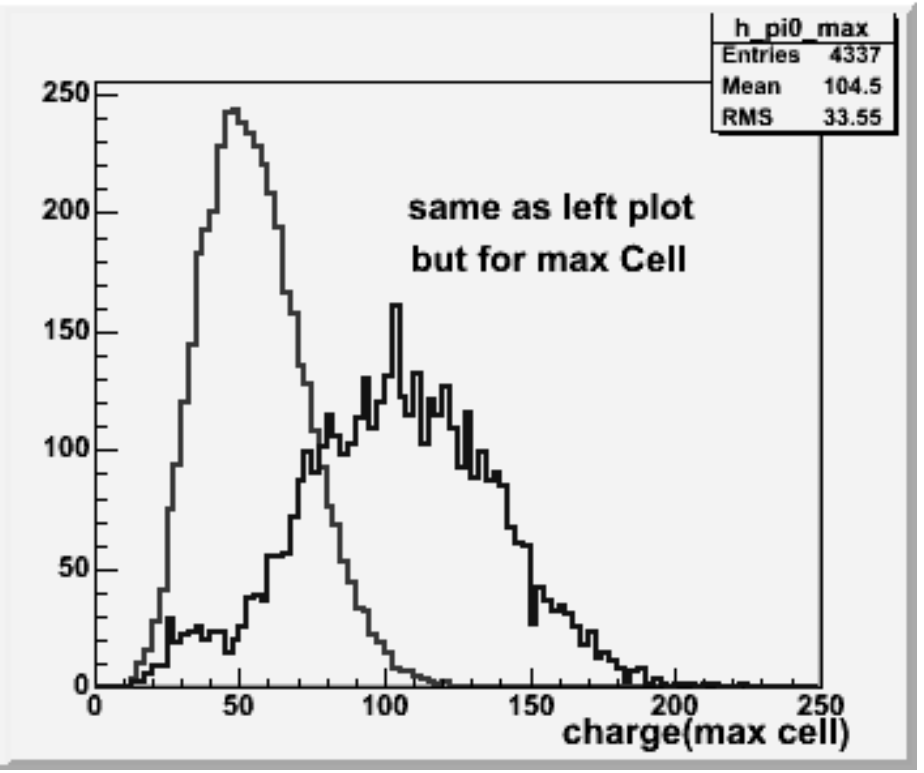

Another option is choose the overlapping trigger tile as shown in left plot. It garentee to hold the whole blob energy but a lot more expensive electronically. This is called super cell method

Study shows the two choices are not very much different from each other.

# Charge cut to for double hits overlap

The charge distribution for overlapped double hits is studied via pi0 dalitz when two electrons are close enough to overlap. The bottom left shows the blob charge distribution for overlapped double hits (blue) and single hits (red). A cut at 120fC should keep the efficiency high and reject most of the overlapping double hits. Bottom right plot shows the same thing for the cells with maximum charge in the blob.  A cut at 100fC should keep efficiency high and reject half of the double hits.



# Efficiency and Rejection factor

Single electron efficiency is studied via merging single electron with p-p minimum-bias events (/phenix/data09/xiewei/DST/single_merge). The following table shows the efficiency as a function of distance using super cell method. The charge cut is set at 120fC and the distance is in the unit of cell:

| pT \ distance | 5(cell) | 10(cell) | 15(cell) | 20(cell) | 25(cell) |
|---|---|---|---|---|---|
| 0.2-0.3GeV | 62.7% | 62.3% | 61.9% | 61.7% | 61.6% |
| 0.6-0.8GeV | 72.6% | 72.3% | 72.2% | 72.2% | 72.1% |
| 1.5-2.0GeV | 74.6% | 74.5% | 74.0% | 74.0% | 74.0% |

The efficiency is around 75% which is more or less consistent with the fact that the HBD geometry is misaligned with the central arm by 19 degree. Also the multiplicity effect is very small due to small multiplicity.

The rejection factor with super cell method is shown in the following table( note: data is at:

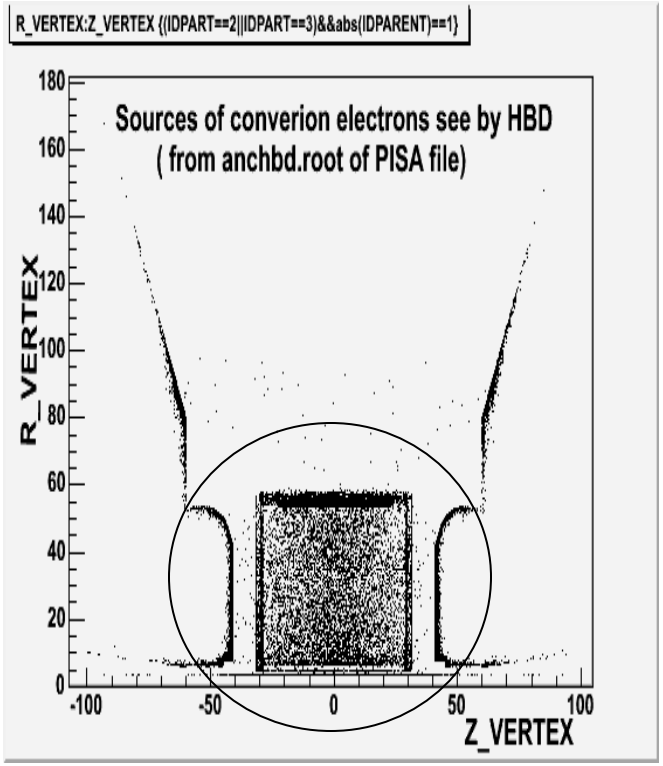
/phenix/data08/xiewei/exodus/work/DST/mini-bias)

| distance | 5(cell) | 10(cell) | 15(cell) | 20(cell) | 25(cell) |
|---|---|---|---|---|---|
| RF: | 41.0 | 41.8 | 42.0 | 42.5 | 43.5 |

The rejection factor is low and surprisingly it does not change very much with the distance cut.

# Further study on Rejection factor

The following plot shows the vertex distribution of electrons passing through HBD pad plane. Only the part in the circle can be seen by HBD since they pass through the radiator.  1000 p-p minimum-bias events is analyzed event by event to study the reason for the weak dependence of distance cut.




The RF is expected to be worse when including beam related background

In the 1000 events, 20 are accepted and they are:

1. 8 events contains single electrons from nosecone. Might be due to the remaining field near nosecode kicked out the other one ?
2. 3 events contains conversion with both e+e- seen by HBD but the with small charge. My understanding is the pathlength in the radiator is too small
3. 3 events contains single electrons from pi0 dalitz decay.
4. 2 events contain single electrons from hadron decay.
5. 4 events from unknown reason.

# Another possible algorithm

Inspiration from discussion with Matthias and Yasuyuki suggest:

- one can try to correlate HBD with ERT trigger or RICH only. In the case of the 1000 events shown in previous page: category 1, 2, 5 are expected to be rejected and the rejection factor might improve by a factor of ~4 or more depending on the momentum of the electrons.
- Both HBD and RICH have a pion threshold of 4GeV. The combination might produce a very efficiency high pT charge particle trigger.